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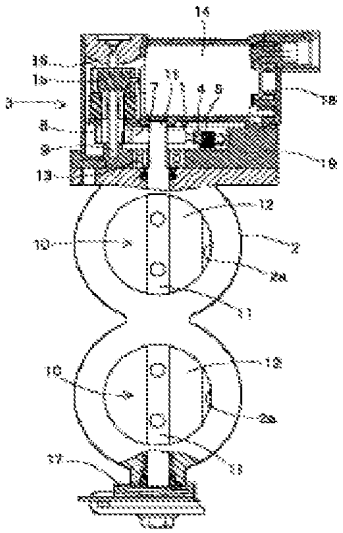
(54)【Title of the Invention】A valve device for intake control in an internal combustion engine

(57)【Abstract】

【Objective】The present invention is to provide a valve device for intake control for an internal combustion engine at the working edge of an intake control valve so as to maintain the valve in a fixed and stable position even when an actuator is stopped operating.

【Solutions to the Problems】In the present valve device for intake control, a valving element 12 is rotated around a valve axis 11 using a drive motor 14. When the valving element 12 is rotated up to the working edge, a permanent magnet 4 on a partial gear 7 comes into contact with and becomes attached to a permanent magnet 5 or 6 on a positioning bolt 20 or 21, respectively, on the fixed side and stops there. In the event that the valving element 12 in the intake pipe is forced in the direction of open or close by wind pressure or vibration, the movements of the valve axis 11 and the valving element 12 are completely stopped by the contact between the permanent magnet 4 and the permanent magnet 5 or 6.



【Claims】

【Claim 1】 A valve device for intake control in an internal combustion engine comprising a valving element provided in an intake pipe in such a manner that it can rotate for opening or closing and an actuator that rotates and drives said valve axis, wherein a permanent magnet is attached to a component that rotates together with said valve axis; and a permanent magnet or magnetic absorbent is installed on the fixed side that comes into contact with and becomes attached to said permanent magnet when said permanent magnet rotates up to the working edge of said valving element together with said valve axis.

【Claim 2】 A valve device for intake control in an internal combustion engine comprising a valving element provided in an intake pipe in such a manner that it can rotate for opening or closing and an actuator that rotates and drives said valve axis, wherein a magnetic absorbent is attached to a component that rotates together with said valve axis; and a permanent magnet is installed on the fixed side that comes into contact with and becomes attached to said magnetic absorbent when said magnetic absorbent rotates up to the working edge of said valving element together with said valving axis.

【Claim 3】 The valve device for intake control in an internal combustion engine according to claim 1, wherein said permanent magnet is attached to part of a partial gear that rotates together with the valve axis.

【Claim 4】 The valve device for intake control in an internal combustion engine according to claim 2, wherein said magnetic absorbent is attached to part of a partial gear that rotates together with the valve axis.

【Claim 5】 The valve device for intake control in an internal combustion engine according to claim 1, wherein said permanent magnet or magnetic absorbent installed on the fixed side is attached to the tip of a positioning bolt in such a manner that the adjustment of positioning is possible.

【Claim 6】 The valve device for intake control in an internal combustion engine according to claim 2, wherein said permanent magnet installed on the fixed side is attached to the tip of a positioning bolt in such a manner that the adjustment of positioning is possible.

【0001】

【Technical Field of the Invention】The present invention relates to a valve device for intake control in an internal combustion engine suitably used as a swirl control valve or an intake pipe length control valve in the intake system.

【0002】

【Prior Art】 To take an example for a valve device for intake control used for the intake system of an internal combustion engine, an intake swirl generating device is known. Such a device generates a swirl for intake air led to the cylinder chamber at the time of low speed rotation in order to increase combustion speed and enhance combustion efficiency, which in turn improves fuel efficiency and reduces harmful exhaust gas components.

【0003】 For the swirl control valve used for an intake swirl generating device, a wider main port and a narrower swirl port are usually formed inside the passage on the downstream side of a throttle valve in the intake pipe. They are arranged in such a way that the main port can be opened or closed. At the time of low speed rotation, the main port is closed and intake air is passed through the narrow swirl port installed on the side of surrounding walls in order to generate a drift of intake air in the intake pipe. As a result, a swirl is generated. The swirl control valve is usually controlled at two positions in such a way that the main port is closed at the time of low speed rotation of an engine and opened at the time of middle to high speed rotation.

【0004】 In such a swirl control valve, a butterfly-shaped valving element is driven for opening or closing using a motor through a worm or worm wheel in order to hold the valving element at two positions: fully opened and closed positions. Even when the electricity for a motor is turned off, the valve can be held at fully opened or closed position by the self-lock mechanism of a worm (rotational force from the valving element is locked).

【0005】

【Problems that the Invention is to Solve】 Even in this transmission mechanism, however, there is a small gap between a worm and a worm wheel. If the worm is in the rotatable state, the opened valve could be closed and the closed valve could be opened under wind pressure or vibration.

【0006】For this reason, when the valve is fully closed or opened, the electricity must be turned on for a drive motor for a short period after the valve stops by hitting a stopper so that torque is generated in the same direction. In this manner, a worm and a worm wheel are forced to mesh with each other and the valve can be held at either fully opened or closed position.

【0007】The problem occurs, however, when such a locking state between a worm and a worm wheel lasts for a long period. A very large starting torque is required at a time when the valve must be moved by rotating the worm and worm wheel, so much so that the motor fails to operate.

【0008】For this reason, the transmission mechanism of a spur gear is used in place of a worm and a worm wheel. The electricity is kept on for a motor even after the valve reaches the fully opened or closed position and is stopped by contacting a stopper. Although the valve can be held at the stopped position, the electricity must be kept on for a long period. As a result, power consumption rises and the lifespan of a motor shortens.

【0009】In light of the above-mentioned points, the present invention aims at providing a valve device for intake control for an internal combustion engine at the working edge of an intake control valve so as to maintain the valve in a fixed and stable position even after an actuator stops operating.

【0010】

【Means of Solving the Problems】In order to achieve the abovementioned objective, the valve device for intake control in an internal combustion engine according to claim 1 of the present invention is characterized by comprising a valving element provided in an intake pipe in such a manner that it can rotate for opening or closing and an actuator that rotates and drives said valve axis, where a permanent magnet is attached to an component that rotates together with said valve axis, and a permanent magnet or magnetic absorbent is installed on the fixed side that comes into contact with and becomes attached to said permanent magnet when said permanent magnet rotates up to the working edge of said valving element together with said valving axis.

【0011】The valve device for intake control according to claim 2 is characterized by comprising a valving element provided in an intake pipe in such a manner that it can rotate for opening or closing and an actuator that rotates and drives said valve axis, where a magnetic absorbent is attached to an component that rotates together with said valve axis, and a permanent magnet is installed on the fixed side that comes into contact with and becomes attached to said magnetic absorbent when said magnetic absorbent rotates up to the working edge of said valving element together with said valving axis.

【0012】

【Operation of the Invention】In such a valve device for intake control, a permanent magnet installed on a rotating component comes into contact with and becomes attached to a permanent magnet or magnetic absorbent installed on the fixed side when a valving element is rotated by an actuator up to the working edge through a valve axis. Or a magnetic absorbent installed on a rotating component comes into contact with and becomes attached to a permanent magnet installed on the fixed side.

【0013】For this reason, the valving element in the intake pipe can be stopped and self-held at the stopped position even when it was forced in the opening or closing direction under wind pressure or vibration. The valving element can be self-held by the attracting force of a magnet. The attracting force of a magnet is adjustable to less than the starting torque of an actuator. That eliminates the necessity of holding the valve at the fully opened or closed position by forcibly meshing and locking a worm with a worm wheel as seen in a traditional device. Thus, it is most likely to prevent an actuator from failing to start operating. Also it is not necessary to keep turning on the electricity for an actuator (motor) in order to maintain the fully opened or closed position as seen in a traditional device. Hence, chances are that the lifespan of an actuator (motor) can be prolonged.

【0014】

【Working Examples】The following is the description of a working example of the present invention based on drawings. The drawings show an example of the present invention applied to a swirl control valve of an intake swirl generation device used for an internal combustion engine. Figure 1 shows a top view of an intake swirl generation device with partial sectional views. The numeral 2 is an intake pipe block fixed on the intake port of a cylinder head. Inside the intake pipe block 2 is the intake passage 2a formed. The swirl control valve 10 of the intake swirl generation device is installed inside the intake passage 2a.

【0015】The swirl control valve 10, which is formed by supporting a butterfly-shaped valving element 12 by means of a valve axis 11, is installed inside the intake passage 2a of the intake pipe block. The plane shape of the valving element 12 has a flat portion at its tip. Only a section near the wall of the intake passage is opened at a time when the swirl control valve 10 is fully closed in order to generate an intake drift near the intake port. As a result, an intake swirl is generated inside the cylinder.

【0016】 The valve axis goes through the intake passage 2a horizontally and is rotatably supported by a bearing 13. At the end of the valve axis, a return spring 17 is latched so as to power the swirl control valve 10 to the open side at all times. The example in figure 1 is to control the intake passage of a 2-cylinder internal combustion engine. Two intake passage 2a and 2a are installed for two cylinders at the cylinder head. Two valving elements 12 and 12 are installed on the same valve axis 11 and placed in the respective intake passage 2a and 2a. On the lateral side of the intake pipe 2 are an installation base 19 and a case 18 installed. A drive motor 14 and a gear mechanism to transmit its revolution to the valve axis 11 are installed in the case 18. In the installation base 14, a self-holding mechanism 1 for the valve with permanent magnets 4, 5, and 6 are placed.

【0017】 A gear mechanism 3 consists of a partial gear 7 supported at the edge of the valve axis, a spur gear 8 rotatably supported by a gear axis 9 and latched onto the partial gear 7, and a worm wheel 16 linked to the spur gear 8 through a cushion section and supported by the gear axis 9. The worm wheel 16 is meshed with a worm 15 fixed on the rotation axis 14a of the drive motor 14. The spur gear 8 is rotated by the drive motor 14 through the worm 15 and worm wheel 16. The rotation of the spur gear 8 is transmitted to the partial gear 7. As a result, the valve axis 7 (sic) is rotated.

【0018】 The self-holding mechanism 1 is installed on and around the partial gear 7 and consists of a permanent magnet 4 installed on part of the partial gear 7 and permanent magnets 5 and 6 installed at the tip of positioning bolts 20 and 21. The permanent magnet 4 is fixed on the protrusion of the non-gear section of the partial gear 7. Permanent magnets 5 and 6 are fixed on the tips of the positioning bolts 20 and 21, respectively, that are adjustably screwed in the installation base 19.

【0019】 The permanent magnet 4, which rotates together with the partial gear 7, are installed in such a way as to be attached to the permanent magnet 5 at one rotational end and to the permanent magnet 6 at the other end. The swirl control valve 10 rotates around the valve axis 11 in about 85 degrees range, taking two, fully opened and closed, positions.

【0020】 The positioning bolt 20 is screwed in a screw hole on the installation base 19 in such a way that the permanent magnet 4 of the partial gear 7 can be attached to the permanent magnet 5 at the tip of the bolt at a time when the swirl control valve 10 is fully closed. The bolt is fixed to the set position with a nut 22. The positioning bolt 21 is screwed in a screw hole on the installation base 19 in such a way that the permanent magnet 4 of the partial gear 7 can be attached to the permanent magnet 6 at the tip of the bolt at a time when the swirl control valve 10 is fully opened. The bolt is fixed to the set position with a nut 23.

【0021】 The positions of the permanent magnets 5 and 6 can be adjusted by changing the extent of screwing-in of the positioning bolts 20 and 21, respectively. Not only the change from fully closed position to fully opened position, positions are also adjustable by optionally changing the working position of the swirl control valve 10.

【0022】 The drive motor 14 is connected to a controller (not shown). The controller is used to control the drive motor 14 in such a manner as to close the swirl control valve 10 at the time of low speed rotation including the start of an internal combustion engine and idling. By closing the swirl control valve 10, a swirl is generated inside the cylinder and the amount of intake needed for low speed rotation of an engine is secured. At the time of middle to high speed rotation of an engine, the swirl control valve 10 is kept at the fully opened state in order to prevent a swirl from being generated and secure the amount of intake needed for middle to high speed rotation of the engine.

【0023】 Next, we explain how to operate the abovementioned intake swirl generating device. The controller is used to control the drive motor 14 in such a manner as to close the swirl control valve 10 at the time of low speed rotation including the start of an internal combustion engine and idling.

【0024】 The rotation of the drive motor 14 is transmitted to the worm wheel 16 from the rotation axis 14a through the worm 15. The rotation of the worm wheel 16 causes the spur gear 8 to be rotated. The rotation is transmitted to the valve axis of the swirl control valve 10 through the partial gear 7. The partial gear is rotated to the position as shown in figure 2. As a result, the valving element is set to the fully closed state. When the partial gear 7 is rotated to the fully closed position of the valving element, the permanent magnet 4 installed on the protrusion of its non-gear section comes into contact with and becomes attached to the permanent magnet 5 of the fully closed position. The attachment of permanent magnets 4 and 5 causes the valving element 12 of the swirl control valve 10 to be kept at the fully closed state.

【0025】When the swirl control valve 10 is kept at the fully closed state, intake air flowing through the intake passage 2a flows only the opening section near the wall at the tip of the valving element 12. As a result, an intake swirl is generated near the intake port, which in turn leads to the generation of an intake swirl inside the cylinder. The swirl accelerates the combustion speed inside the cylinder 4, improving combustion efficiency. Fuel efficiency is therefore improved and harmful exhaust gas components are reduced during idling and low speed rotation.

【0026】The drive motor 14 can be controlled in such a way that the swirl control valve 10 is kept at the fully opened state at the time of middle to high speed of the rotation of an internal combustion engine. In this case, the drive motor 14 rotates in the opposite direction. The rotation of the drive motor 14 is transmitted to the worm wheel 16 from the rotation axis 14a through the worm 15. The rotation of the worm wheel 16 causes the spur gear 8 to be rotated. The rotation is transmitted to the valve axis of the swirl control valve 10 through the partial gear 7. The partial gear is rotated to the position as shown in figure 3. As a result, the valving element is set to the fully opened state.

【0027】When the partial gear 7 is rotated to the fully opened position of the valving element, the permanent magnet 4 installed on the protrusion of its non-gear section comes into contact with and becomes attached to the permanent magnet 6 of the fully opened position. The attachment of permanent magnets 4 and 6 causes the valving element 12 of the swirl control valve 10 to be kept at the fully opened state. When the swirl control valve 10 is fully open, an intake swirl is prevented from being generated. As a result, the amount of intake air needed for middle to high speed of the rotation of an internal combustion engine is supplied through the intake pipe.

【0028】The permanent magnets 4 and 5 or 4 and 6 are attached to each other when the valving element 12 of the swirl control valve 10 reaches either working edge, and the rotations of the partial gear and the valve axis are kept at their positions. Hence, the valving element can be kept at either working edge even when the electricity for the drive motor 14 is turned off. As a result, unstable conditions of the valving element 12 can be prevented even under wind pressure or vibration.

【0029】As explained above, the valving element 12 can be kept at either working edge by the attachment of the permanent magnets 4 and 5 or 4 and 6. Therefore, only small starting torque is required when the valving element 12 is moved again by starting the drive motor, as compared with a traditional method: locking a worm and a worm wheel by making them mesh with each other. As a result, a motor can be started



without fail. The lifespan of a motor are also prolonged because the valve can be kept at its working edge without keeping turning on the electricity unlike a traditional device.

【0030】In the abovementioned working example, permanent magnets 4, 5, and 6 were installed on the sides of both of the partial gear 7 and the positioning bolts 20 and 21. It is also possible, however, to install a ferromagnetic substance (magnetic absorbent) such as steel, which can be attracted to a permanent magnet, on the side of positioning bolts 20 and 21, when the permanent magnet 4 is installed on the partial gear 7 side. If permanent magnets 5 and 6 are installed on the side of positioning bolts 20 and 21, a ferromagnetic substance (magnetic absorbent) such as steel, which can be attracted to a permanent magnet, may be installed on the partial gear 7 side.

【0031】In the abovementioned working example, the self-holding mechanism 1 was installed around the partial gear 7. The self-holding mechanism can be placed around any rotating components, however, as far as the components can be rotated in the same way as in the valve axis 11.

【0032】In the abovementioned working example, the worm 15 and the worm wheel 16 were used for the gear mechanism 3. Only a combination of spur gears, however, can suffice since the self-holding mechanism 1 based on permanent magnets is used.

【0033】Furthermore, the abovementioned working example is used to explain the swirl control valve 10 installed in the intake system of an internal combustion engine. The present invention, however, may also be applied to an intake pipe length control valve of an intake pipe length control device in which the intake pipe length can be switched to two levels in keeping with frequency of the pulsatile flow of intake air that changes as the rotating speed of an engine changes. Said intake pipe length control valve of an intake pipe length control device is a valve device for intake control installed near an intake manifold of an intake pipe. At the time of low to middle rotating speed of an engine, the valve is closed in such a manner as to lengthen the effective intake pipe length. On the other hand, the valve is opened at the time of high rotating speed of an engine in such a

manner as to shorten the effective intake pipe length. The abovementioned configuration can be applied to the self-holding mechanism of a valve at the stopped position.

【0034】

【Effect of the Invention】In the valve device for intake control in an internal combustion engine according to the present invention, as described above, the valving element in the intake pipe can be stopped and self-held at the stopped position even when it was forced in the opening or closing direction under wind pressure or vibration. The valving element can be self-held by the attracting force of a magnet. The attracting force of a magnet is adjustable to less than the starting torque of an actuator. That eliminates the necessity of holding the valve at the fully opened or closed position by forcibly meshing and locking a worm with a worm wheel as seen in a traditional device. Thus, it is most likely to prevent an actuator from failing to start operating. Also it is not necessary to keep turning on the electricity for an actuator (motor) in order to maintain the fully opened or closed position as seen in a traditional device. Hence, chances are that the lifespan of an actuator (motor) can be prolonged.

【Brief Explanation of Drawings】

【Figure 1】 Top view of the intake swirl generating device of one embodiment of the present invention with partial sectional views.

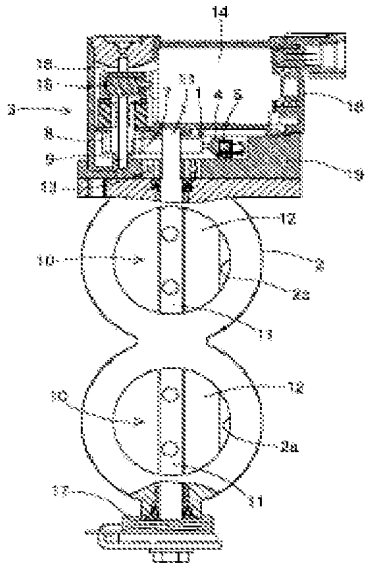
【Figure 2】 Side view of the self-holding mechanism, valves of which are fully closed, installed on the edge of the valve axis 11 of the swirl control valve 10.

【Figure 3】 Side view of the self-holding mechanism, valves of which are fully opened, installed on the edge of the valve axis 11 of the swirl control valve 10.

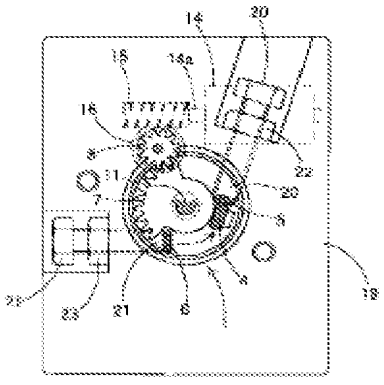
【Explanation of Reference Numerals】

1 - self-holding mechanism
2 - intake pipe block
3 - gear mechanism
4, 5, 6 - permanent magnets
7 - partial gear
10 - swirl control valve
11 - valve axis
12 - valving element
14 - drive motor
15 - worm
16 - worm wheel
20, 21 - positioning bolts

【Figure 1】



【Figure 2】



【Figure 3】